ICECAP

ICECAP/OIB observations of East Antarctica

D. Young[1], D. Blankenship[1] and the ICECAP[1,2,3,4,5] team

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[3] *Australian Antarctic Division*
[4] *LGGE*
[5] *LEGOS*

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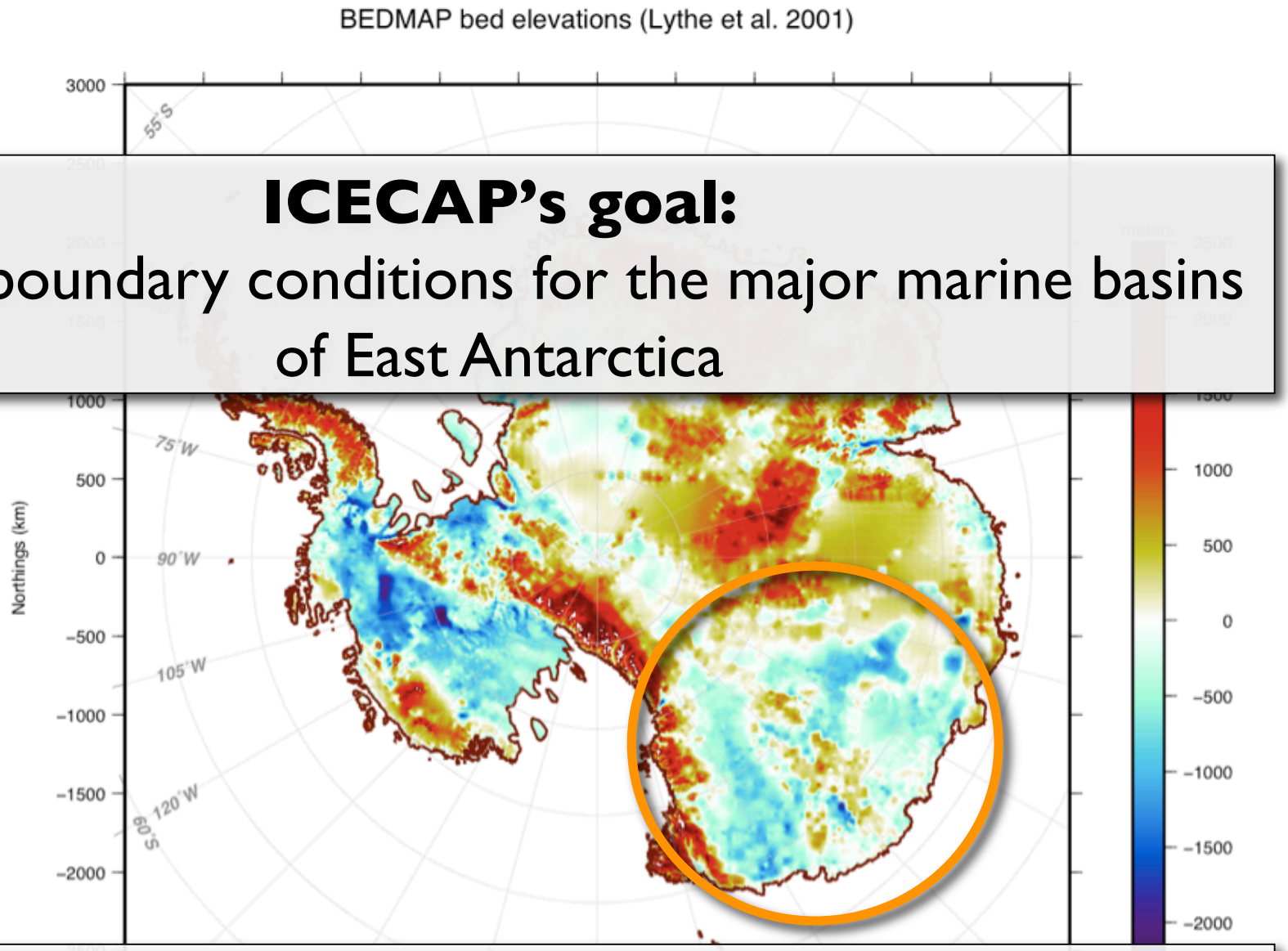
ICECAP's goal:

Improve boundary conditions for the major marine basins of East Antarctica



Requires a long range platform, sustainable operations and international collaboration

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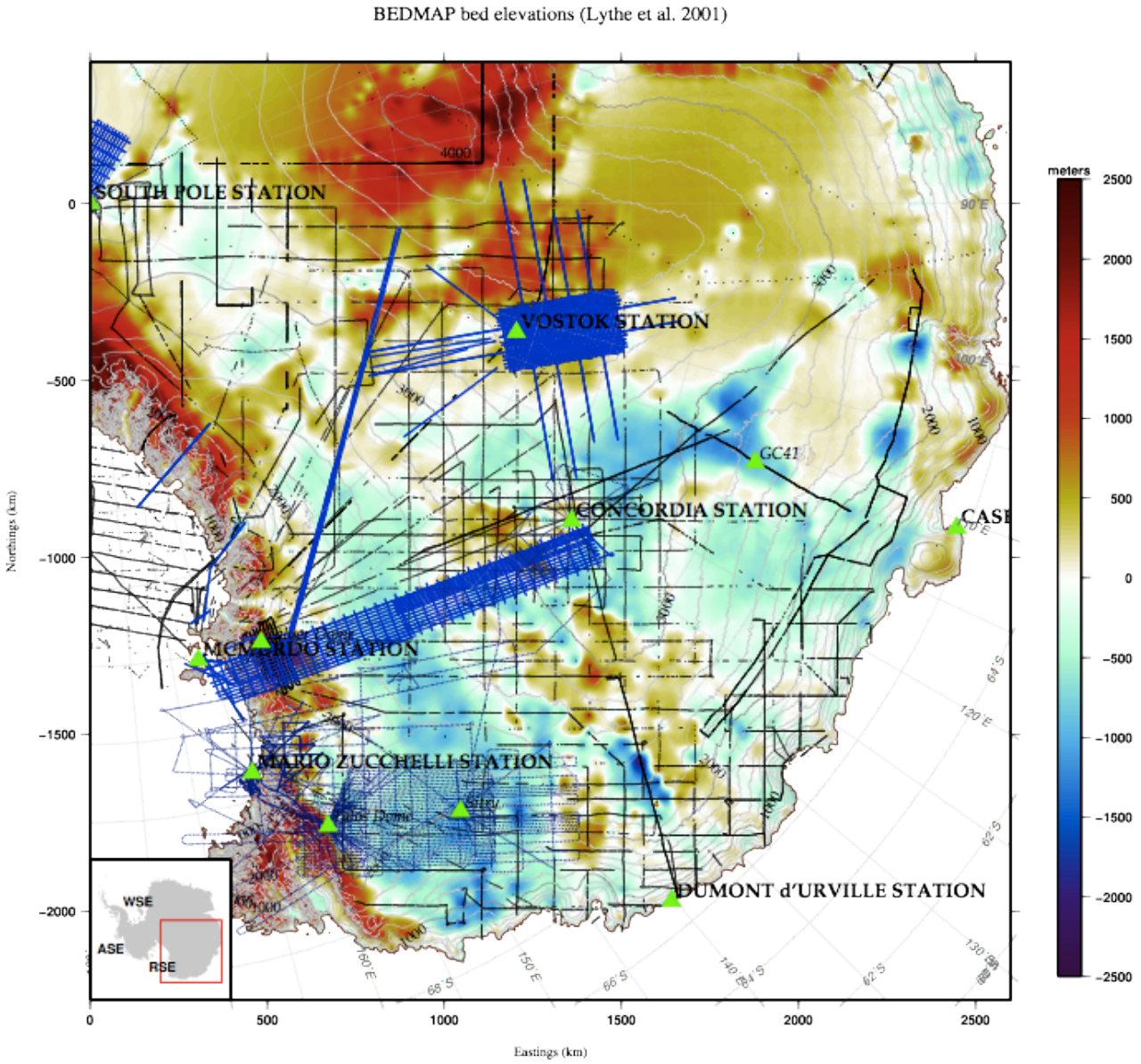

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ICECAP has 2 integrated components:

ICECAP/IPY *(*funding from NSF/NERC/AAD/U.Tas./U.Texas) - three seasons over 2008 to 2011 - focusing on the long term evolution of the East Antarctic Ice Sheet (support from PNRA is pending)
ICECAP/OIB (funding from NASA) - two seasons funded to date between 2009-2011.

Both projects rely on international logistical and scientific support from USAP (USA), AAD (Australia), and IPEV (France).

A third project, ***ICEGRAV*** (NGA/DTU), uses the same aircraft for geodetic surveys in the Antarctica - ICECAP instruments and personnel ride along in a piggyback mode (see Greenbaum talk)

Our season concluded with the return of the aircraft to Austin in late February - a full three months after the end of DC-8 Antarctic operations.

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Motivations for ICECAP:

How **stable** is the East Antarctic Ice Sheet?

Is there a "weak underbelly?" for the EAIS?

What are the **controls** on the large scale architecture of the East Antarctic Ice Sheet?

Underlying geology, subglacial hydrology and variations in accumulation in time and space

What is the potential **climate record** of the East Antarctic Ice Sheet?

The search for old ice records

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Motivations for Ice Bridge:

How are the ice sheets currently changing?

Observations: *Extending ICESAT's record of dz/dt and improving cross track on existing ICESAT lines*

Methods: *altimetry; swath mapping*

Where do marine ice sheet instabilities exist?

Observations: *Ice thickness behind the grounding line.*

Methods: *Ice penetrating radar; gravimetry*

Can ice shelf backstresses change rapidly?

Observations: *Floating ice thickness, structure and cavity geometry*

Methods: *Ice penetrating radar; gravimetry*

Can the basal boundary conditions change rapidly?

Observations: *Basal hydrologic gradients and subglacial water bodies, and sedimentary context*

Methods: *Ice penetrating radar; altimetry; aeromagnetics*

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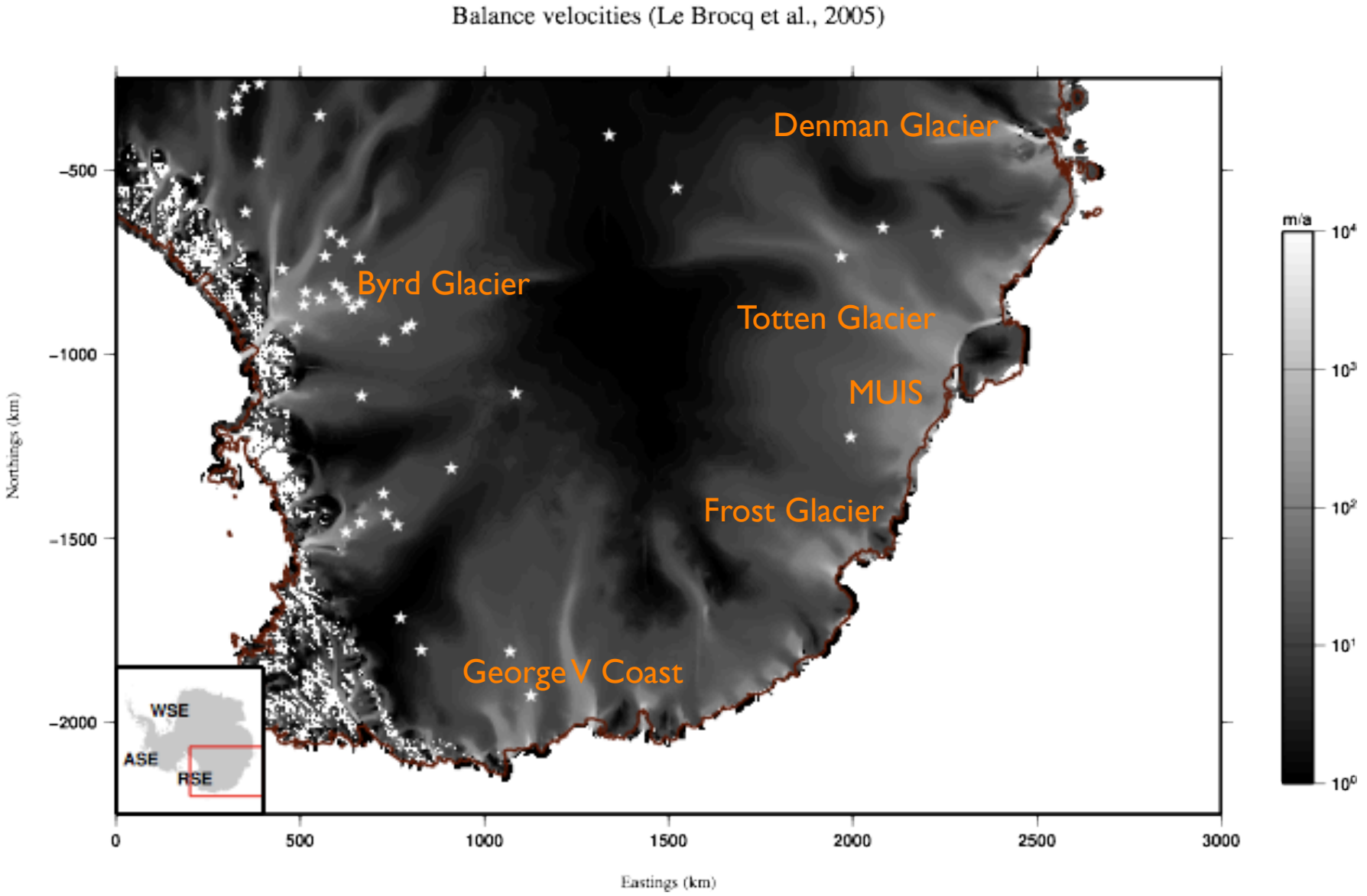

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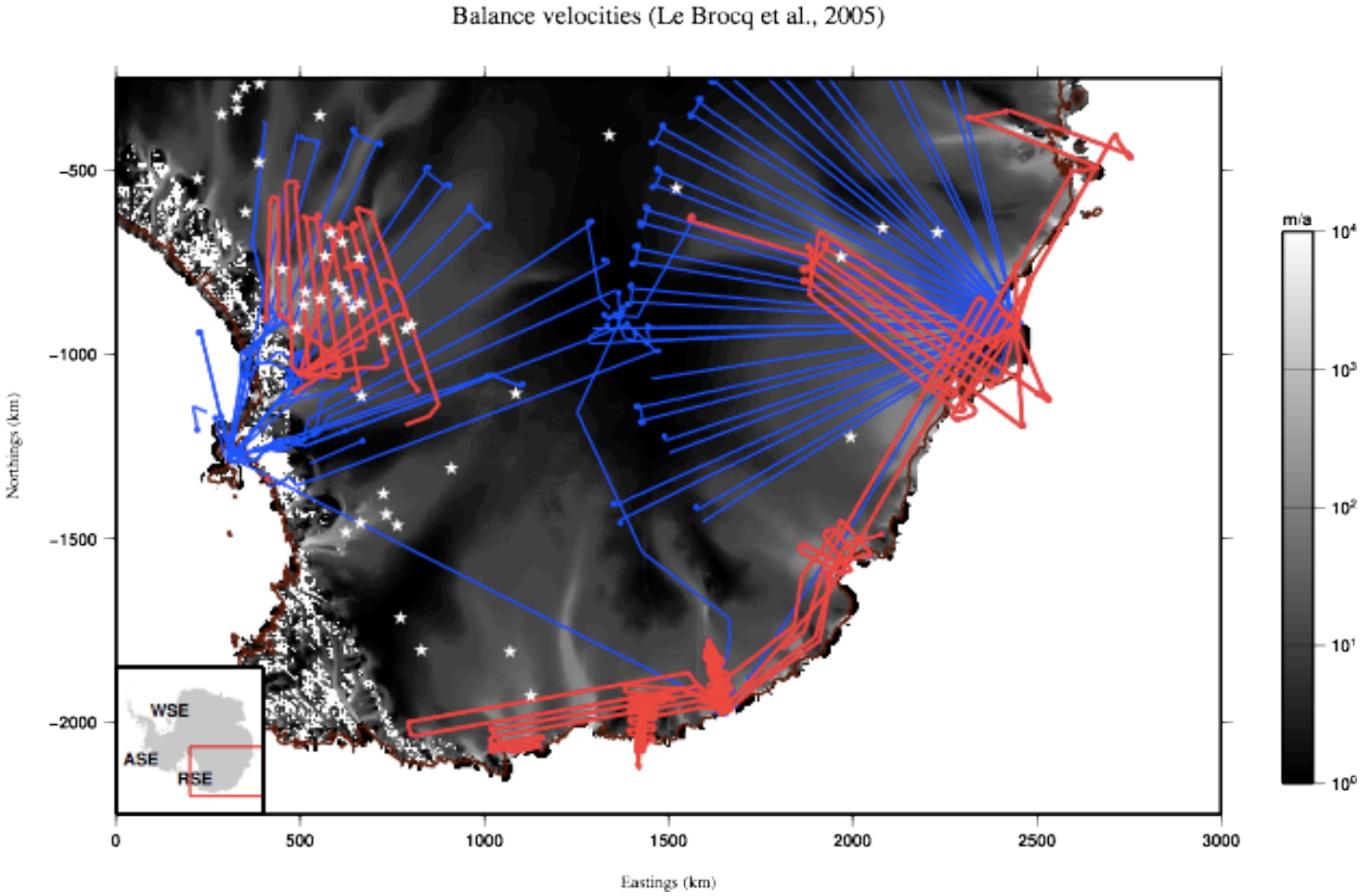

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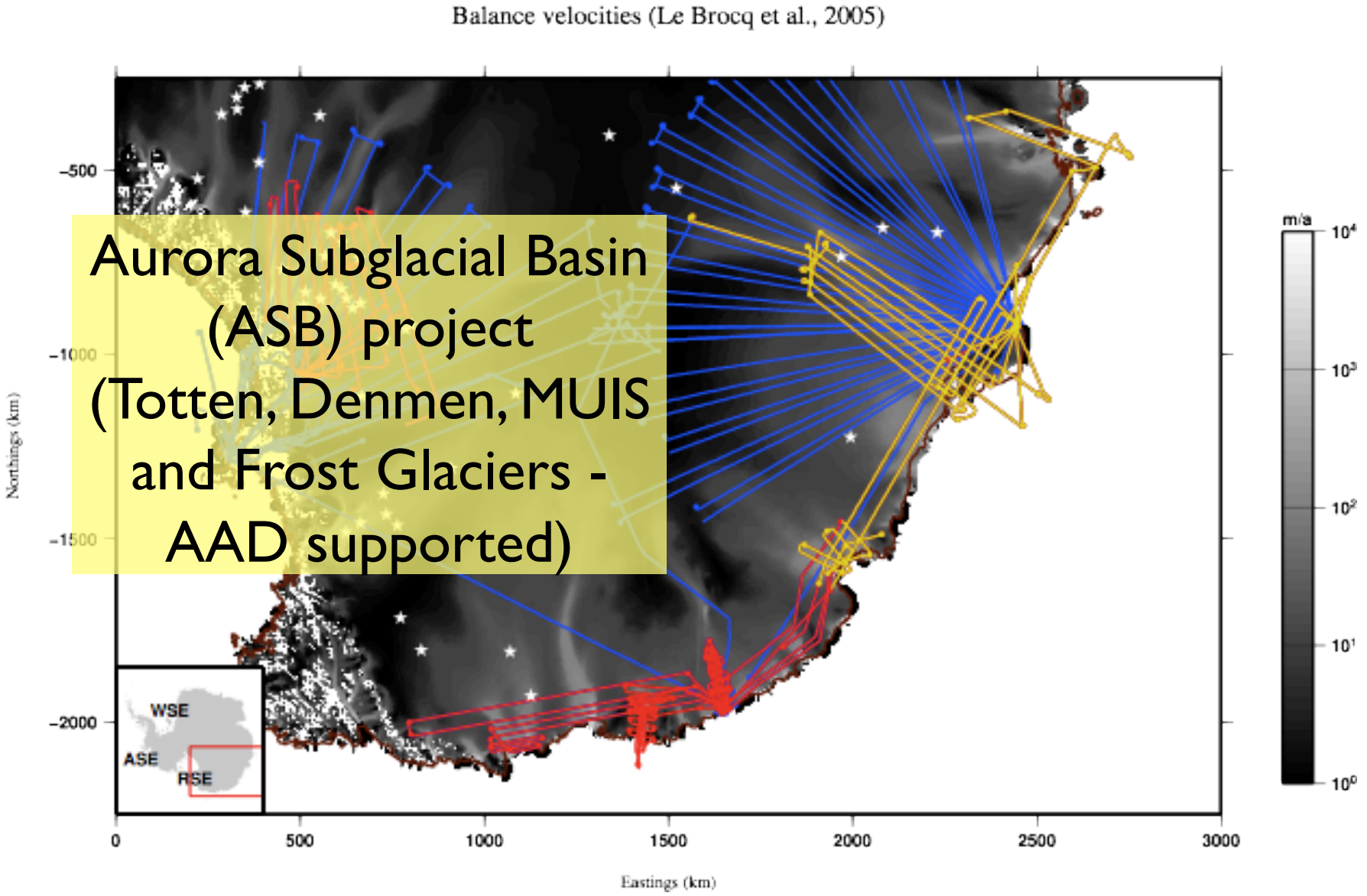
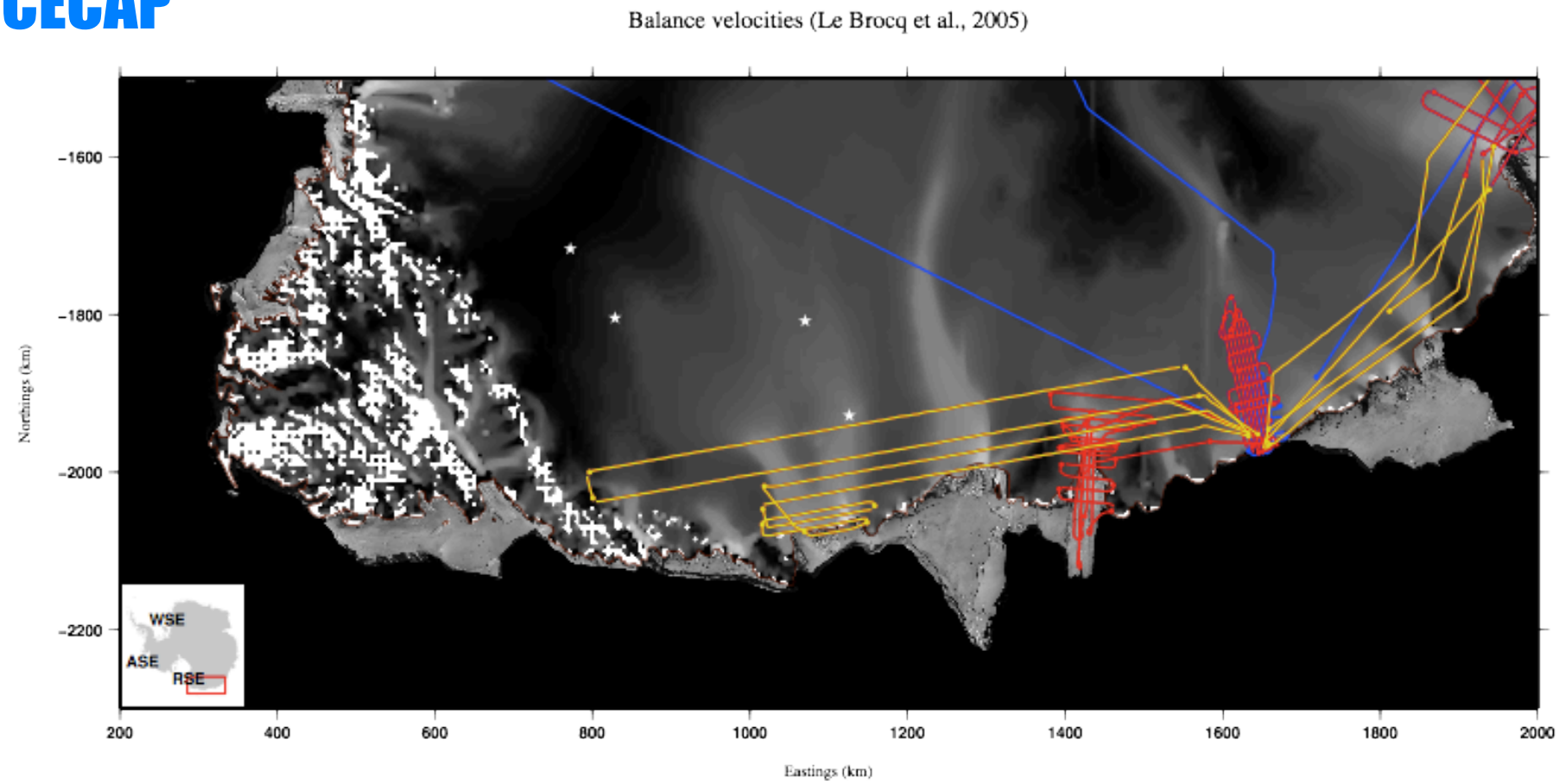

Balance velocities (Le Brocq et al., 2005)
Aurora Subglacial Basin (ASB) project (Totten, Denmen, MUIS and Frost Glaciers - AAD supported)
WSE
ASE
RSE
Northings (km)
Eastings (km)
m/a

ICECAP



North Wilkes Zone (NWZ) project (Matusevich Glacier, Cook Ice Shelf, Ninnis Glacier, Wilkes Coast - IPEV supported)

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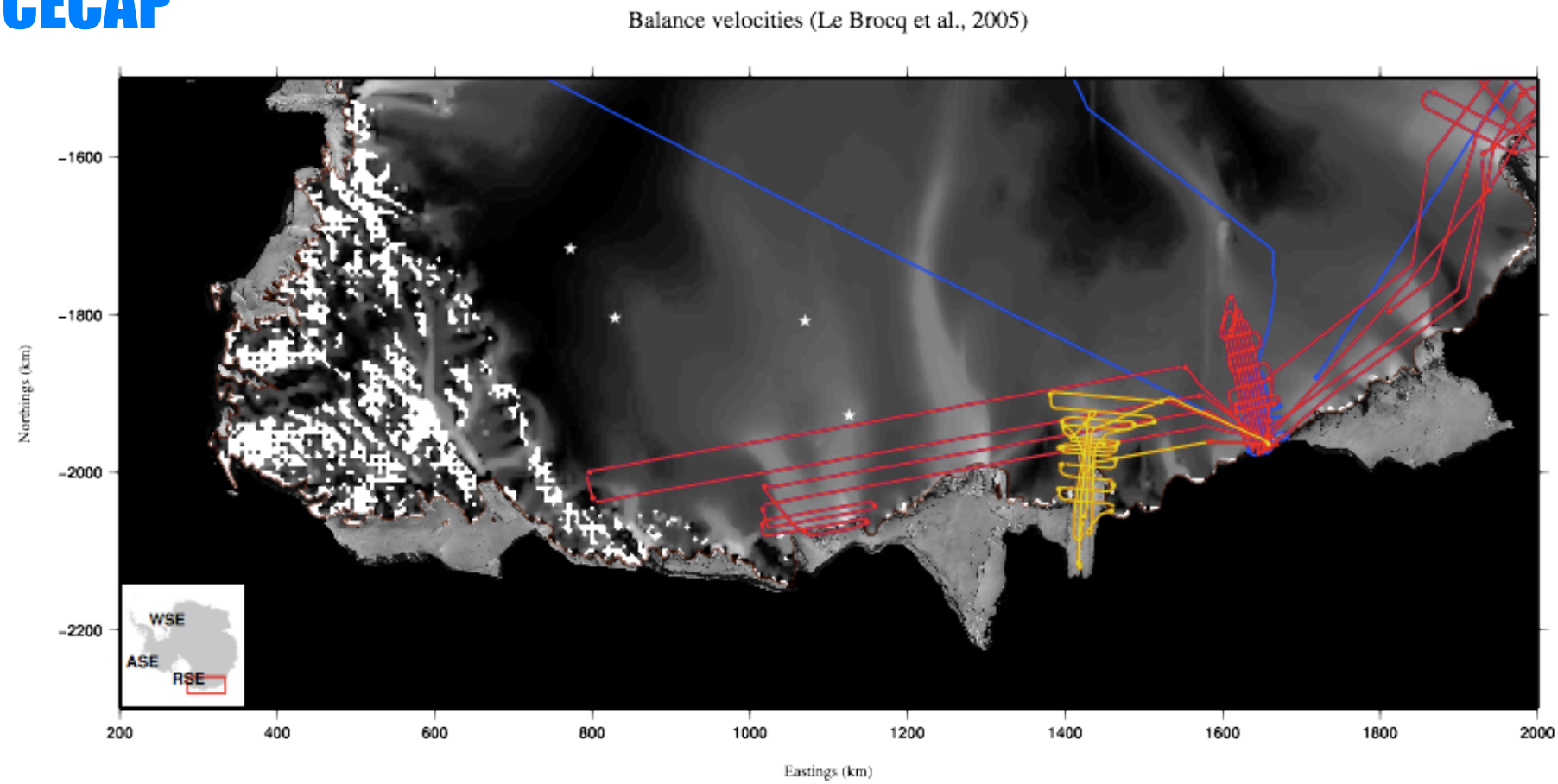

Mertz Glacier (MZG) project
(IPEV supported - CRACICE, WISE collaboration)

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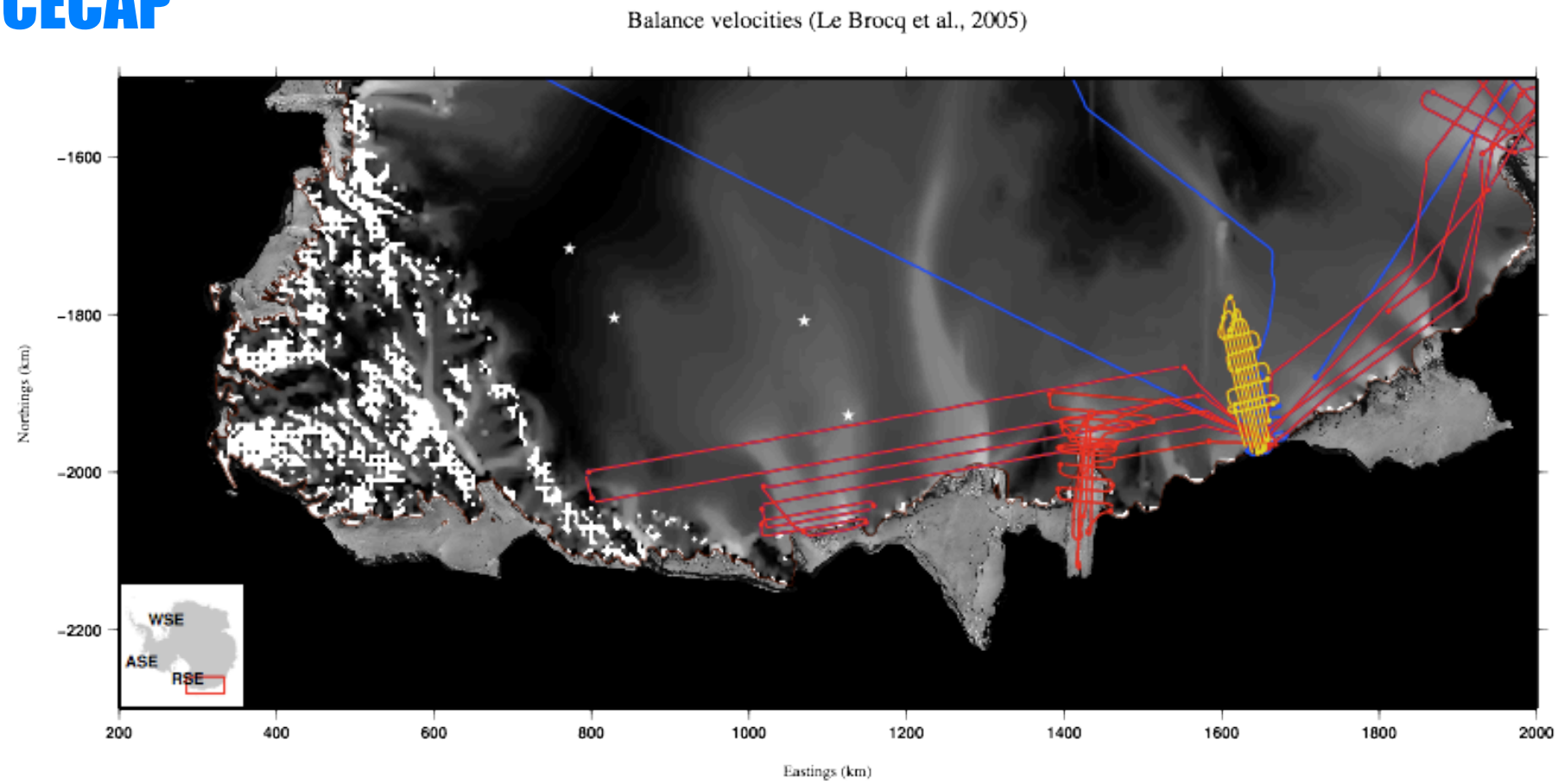

Astrolabe Glacier 2 (ALG2) project (IPEV supported - DATCOA/WISE collaboration)

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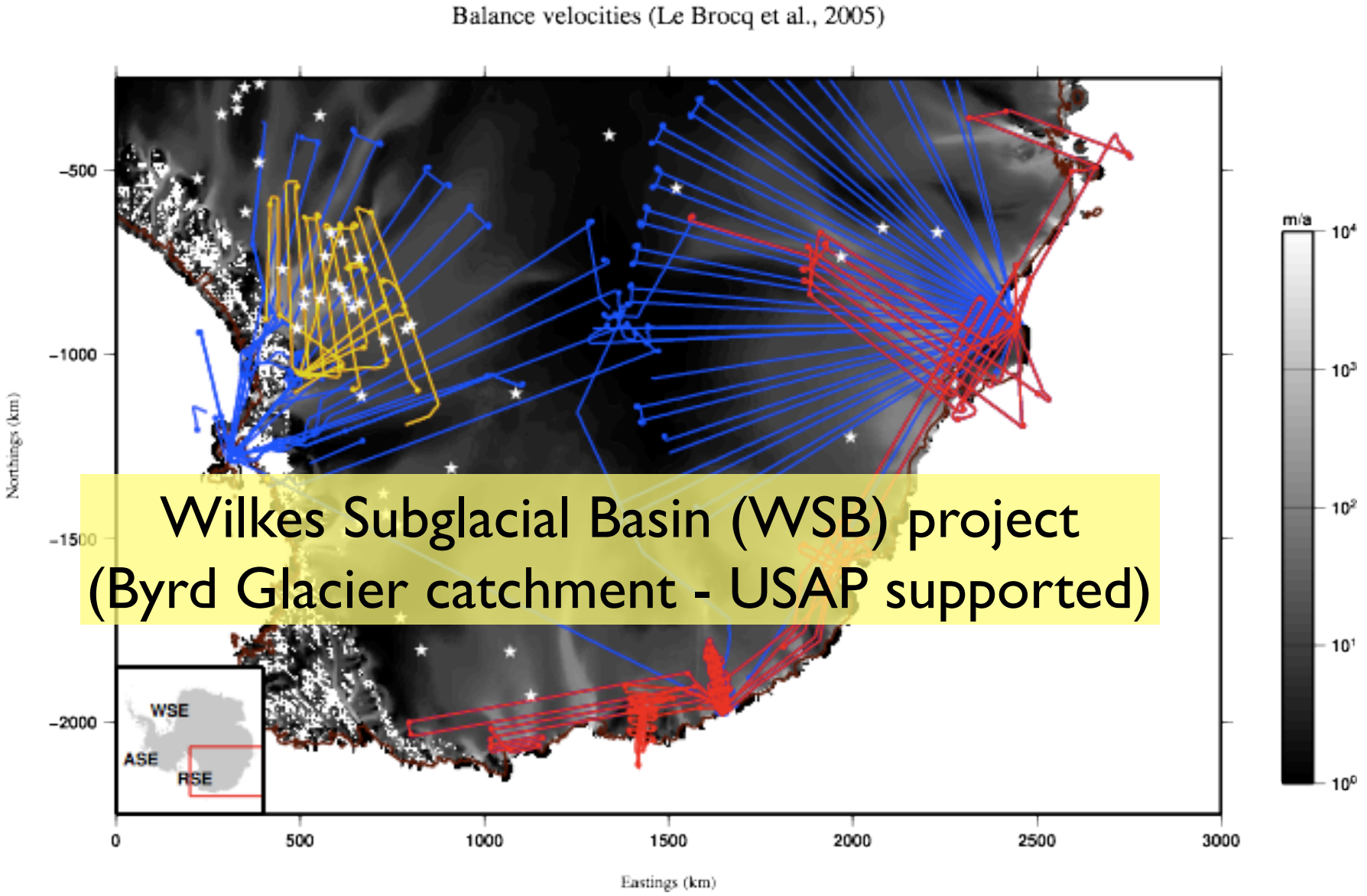
Balance velocities (Le Brocq et al., 2005)
Wilkes Subglacial Basin (WSB) project
(Byrd Glacier catchment - USAP supported)
Northings (km)
Eastings (km)
m/a
WSE
ASE
RSE

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Instruments:

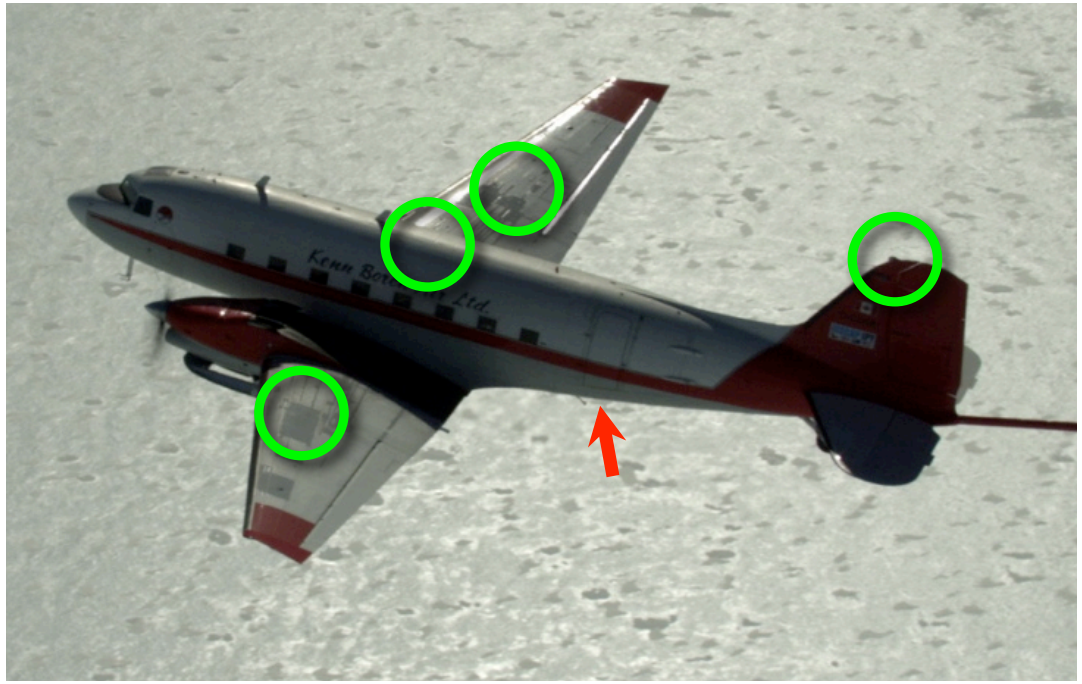
- 60 MHz, 15 MHz bandwidth phase-coherent radar (HiCARS); under wing antennas
- Tail boom mounted Cs-vapor magnetometer (Geometrics 823)
- Gravimeter (Bell Gravity Meter-3)
- Laser rangefinder (Riegl LD-90)
- Photon counting laser altimeter (Sigma Space)
- 2 MHz, 1 MHz bandwidth HF radar (WISE) supported in collaboration with JPL/UCI (see Mouginot talk Thursday)

ICECAP Nadir Altimetry Swath Altimetry Radar Gravity Magnetics

LASER: Riegl LD-90 laser distance meter (3.5 Hz ~ 25 meter) (21,766 km; 67% of ICECAP/OIB profiles) - dropouts due to clouds and rough surfaces (Young et al., 2008 G3 paper)

POSITIONING: TOPCON GB-1000; Ashtech Z-Surveyor

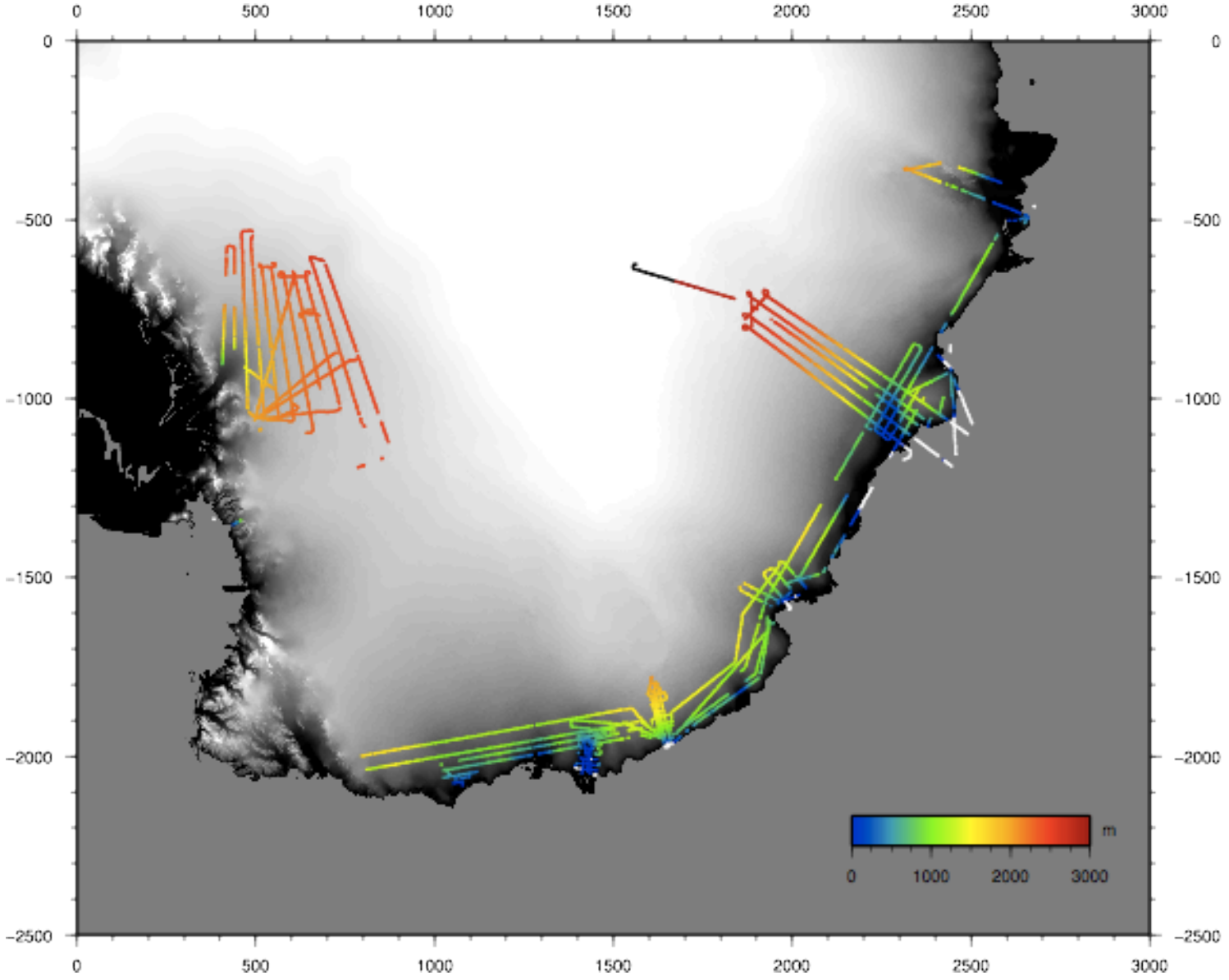
ORIENTATION: Systron-Donner MMQ-G IMU; four point GPS



ISSUES: Full determination of the offset vector between the laser, the IMU and the GPS antennas is in progress. The size of the aircraft requires a full accounting for this offset vector, unlike Twin Otters.

DATA STATUS: Level 0 and 2 data released with no offset vector correction (orientation corrections only).
RMS errors ~1 meters; bias of ~3 meters.
Fully corrected data available in September, with ICECAP/IPY data

ICECAP **Nadir Altimetry** Swath Altimetry Radar Gravity Magnetics



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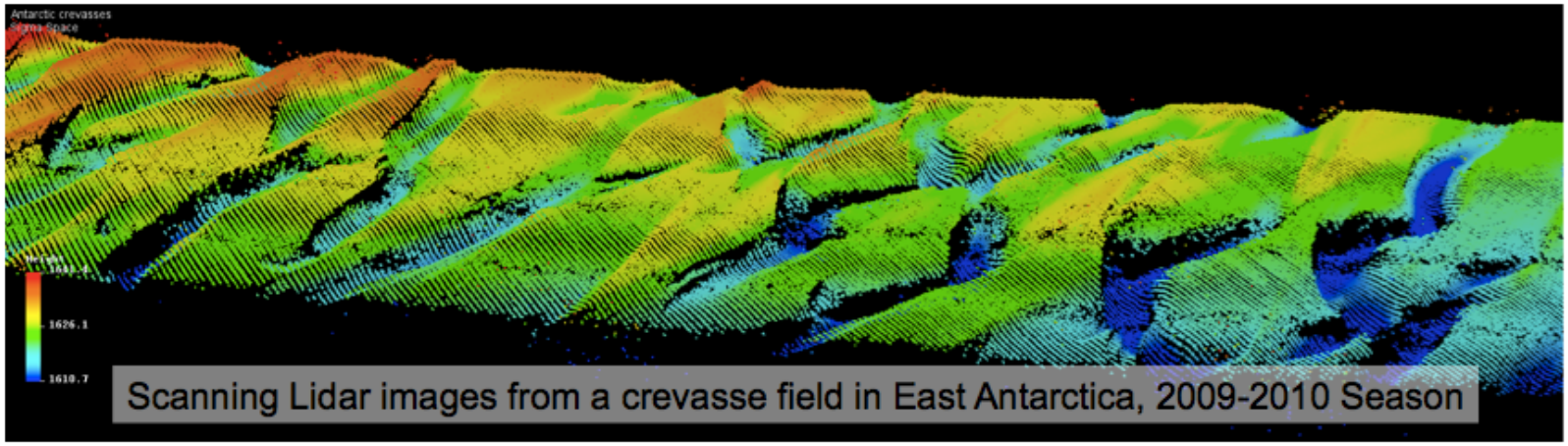
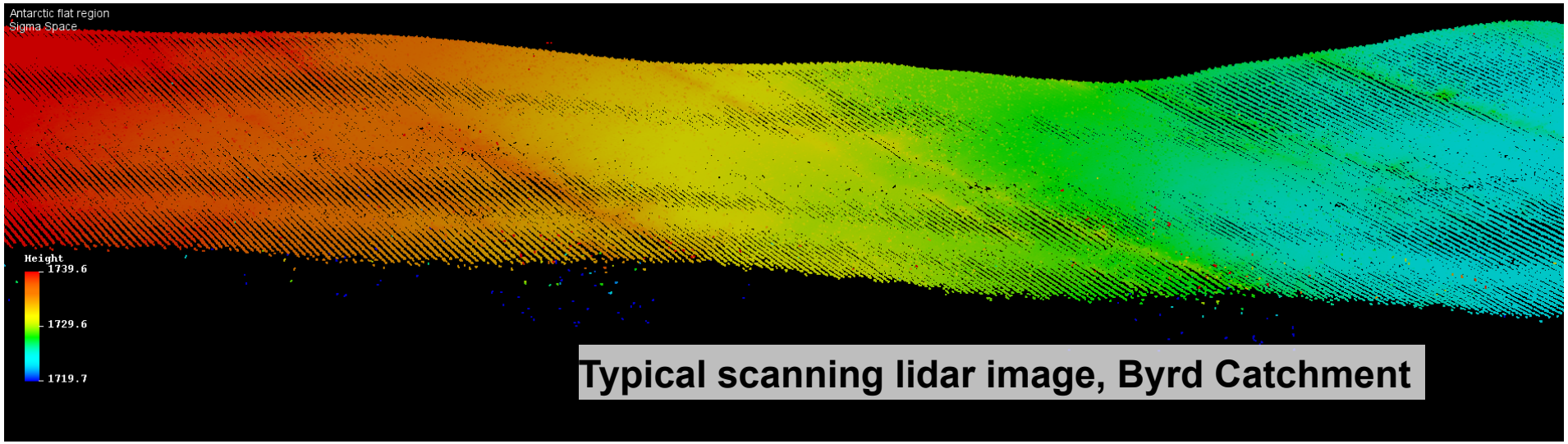


ALTIMETER: Sigma Space Imaging Photon Counting Lidar, 100-beam multistop detector, 20 kHz pulse rate, 20 Hz scan rate

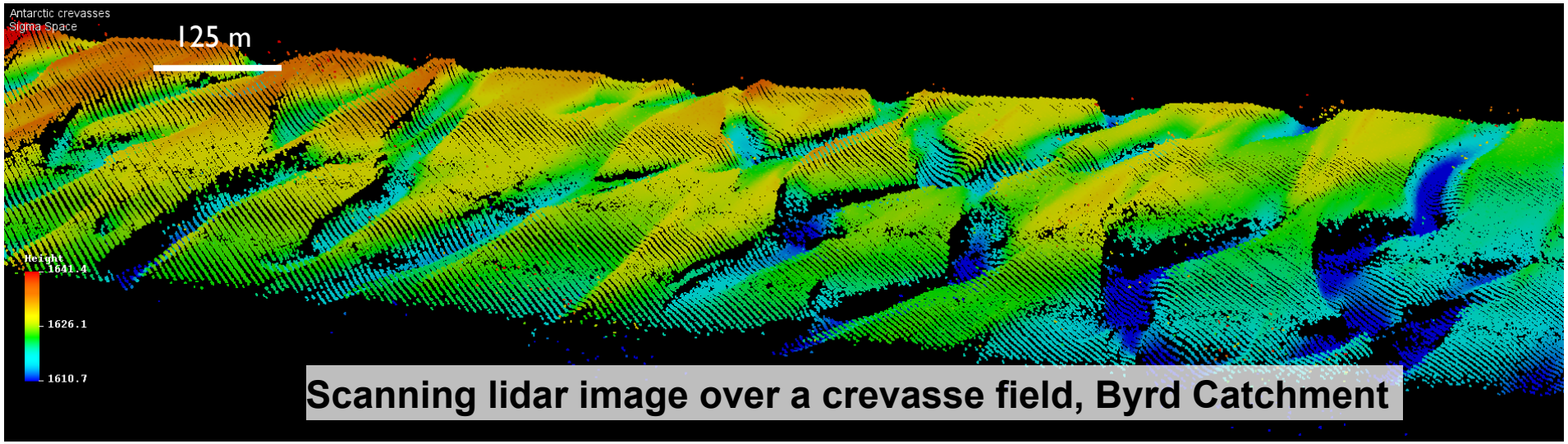
POSITIONING: Novatel OEM-4

ORIENTATION: Honeywell HG1700 AG-58

ISSUES: Given the short lead time, a prototype lidar was used instead of a production system. Data is noisy, voluminous and has internal calibration issues. Data format issues slow our ability to convert this to Level 1B (sequential packet indexing only; no End Of Data indicator). Expect delivery to NSIDC in September; partial Level 0 data already at NSIDC

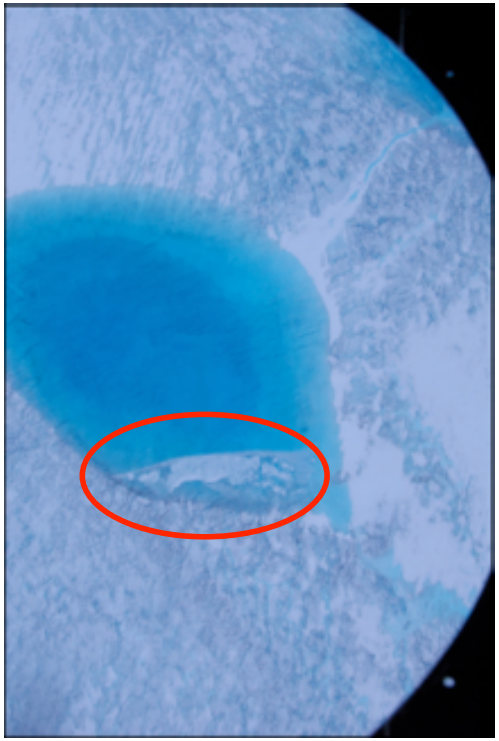


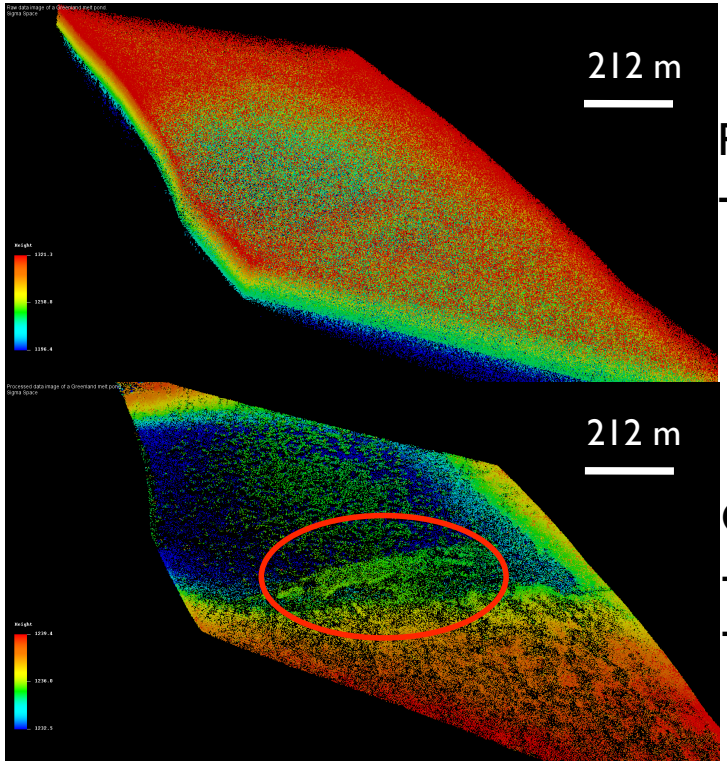
Typical scanning lidar image, Byrd Catchment



Scanning lidar image over a crevasse field, Byrd Catchment

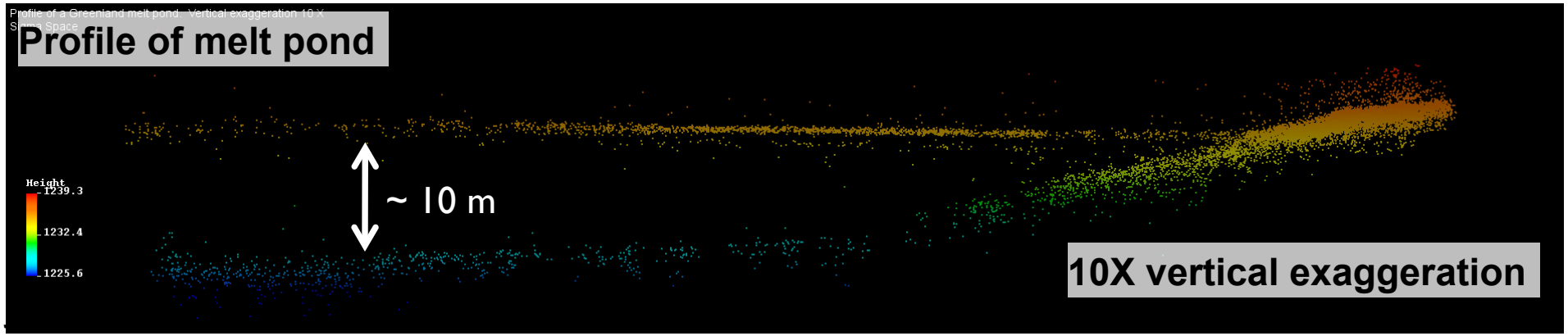
Greenland
Lidar Surface Melt Pond Analysis

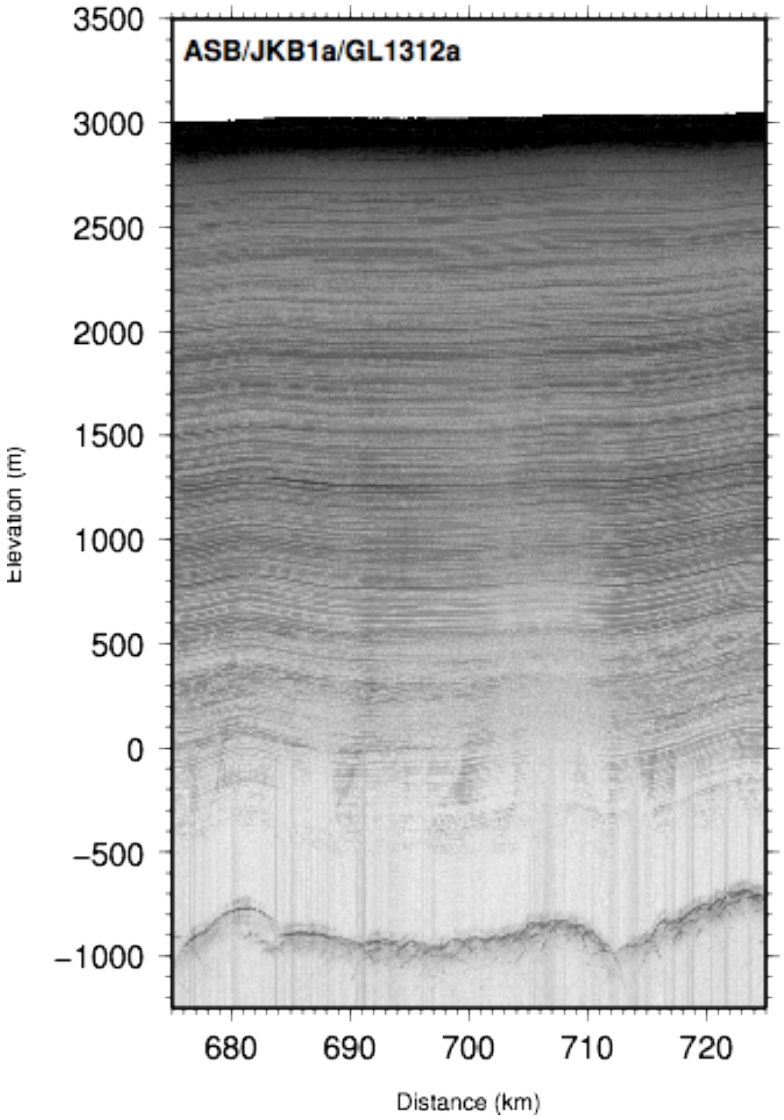




Raw lidar over pond
- Pond visible by reduction of noise events (less red)

Cleaned lidar image
- Green: Pond surface
- Blue: Pond bottom



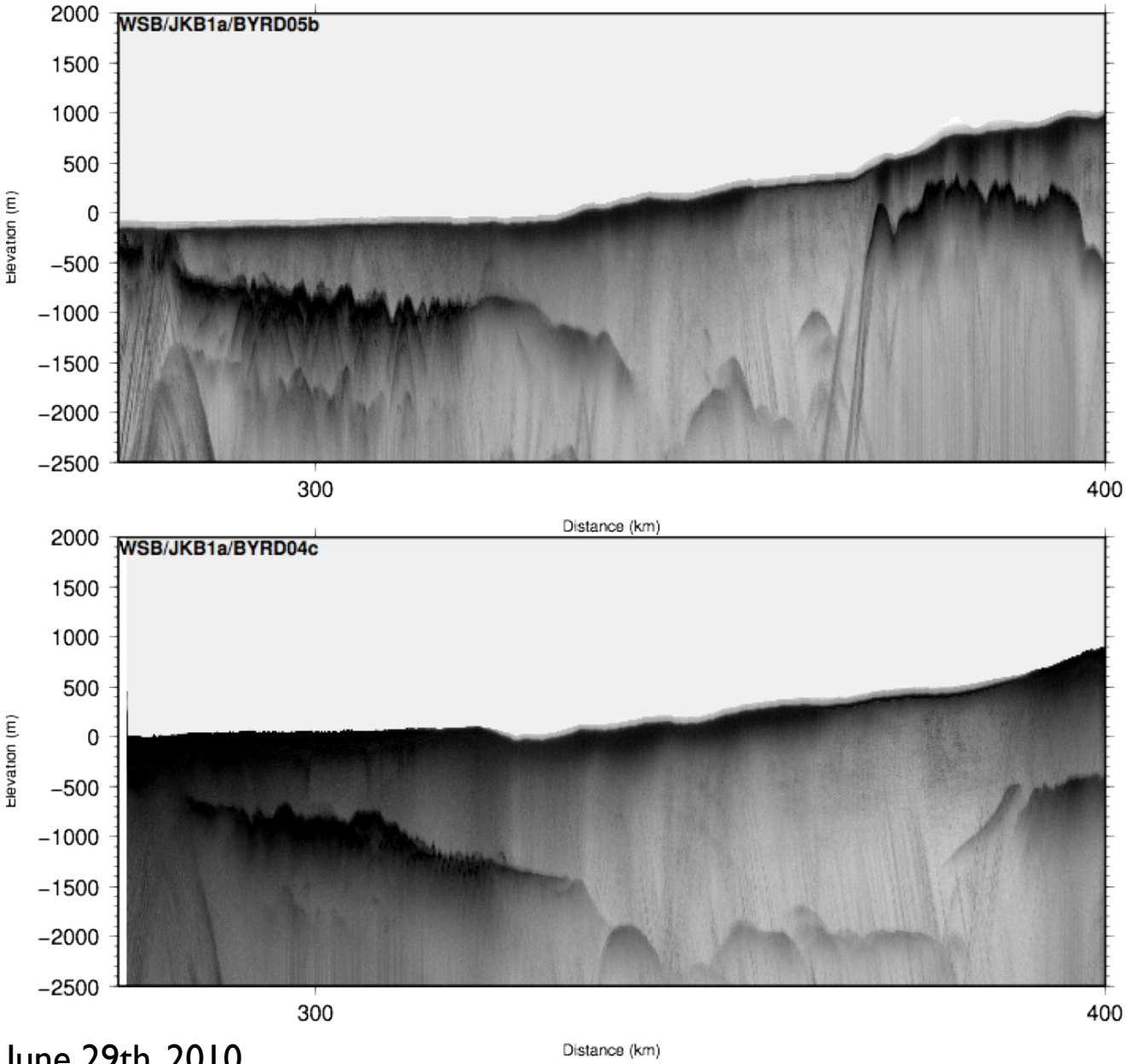


RADAR: 60 MHz, 15 MHz bandwidth, recording at 200 traces per second. Fully calibrated echo intensities. (26764 km of bed detected; 82% of ICECAP/OIB profiles) - dropouts due to no ice and warm ice, and occasional acquisition computer lockups - new acquisition computer being implemented

PROCESSING: "pik1", short coherent, long incoherent stacking to preserve energy over position

DATA: Level 0 data at NSIDC, Level 2 data uploaded with bed elevation, surface elevation, ice thickness, and surface ranges. Level 3 data to be released with ICECAP/ IPY data in September/October

ICECAP **Nadir Altimetry** **Swath Altimetry** **Radar** **Gravity** **Magnetics**



Successful sounding of Byrd Glacier with the HiCARS radar as part of ICECAP/IPY survey lines

Holt et al., OSC meeting

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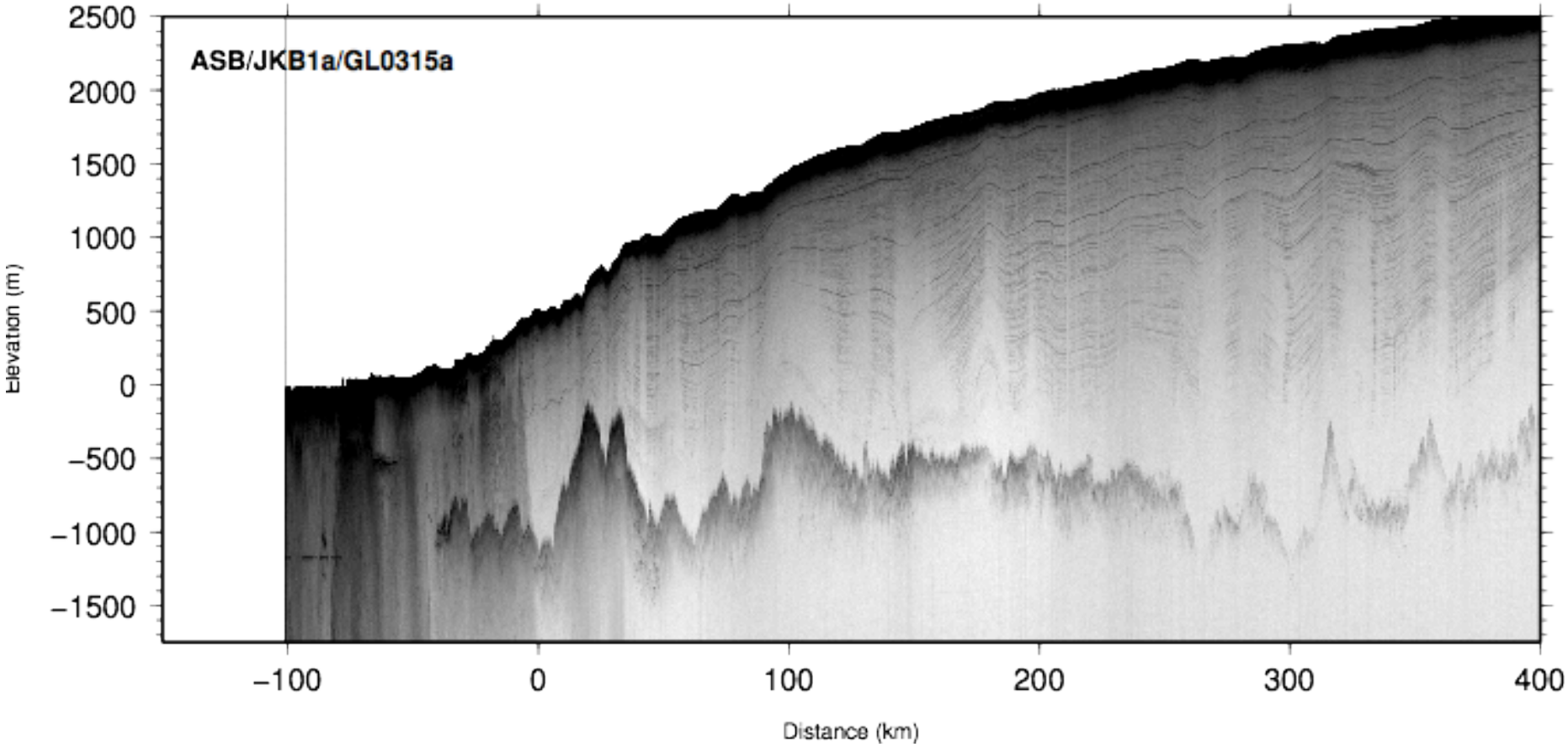
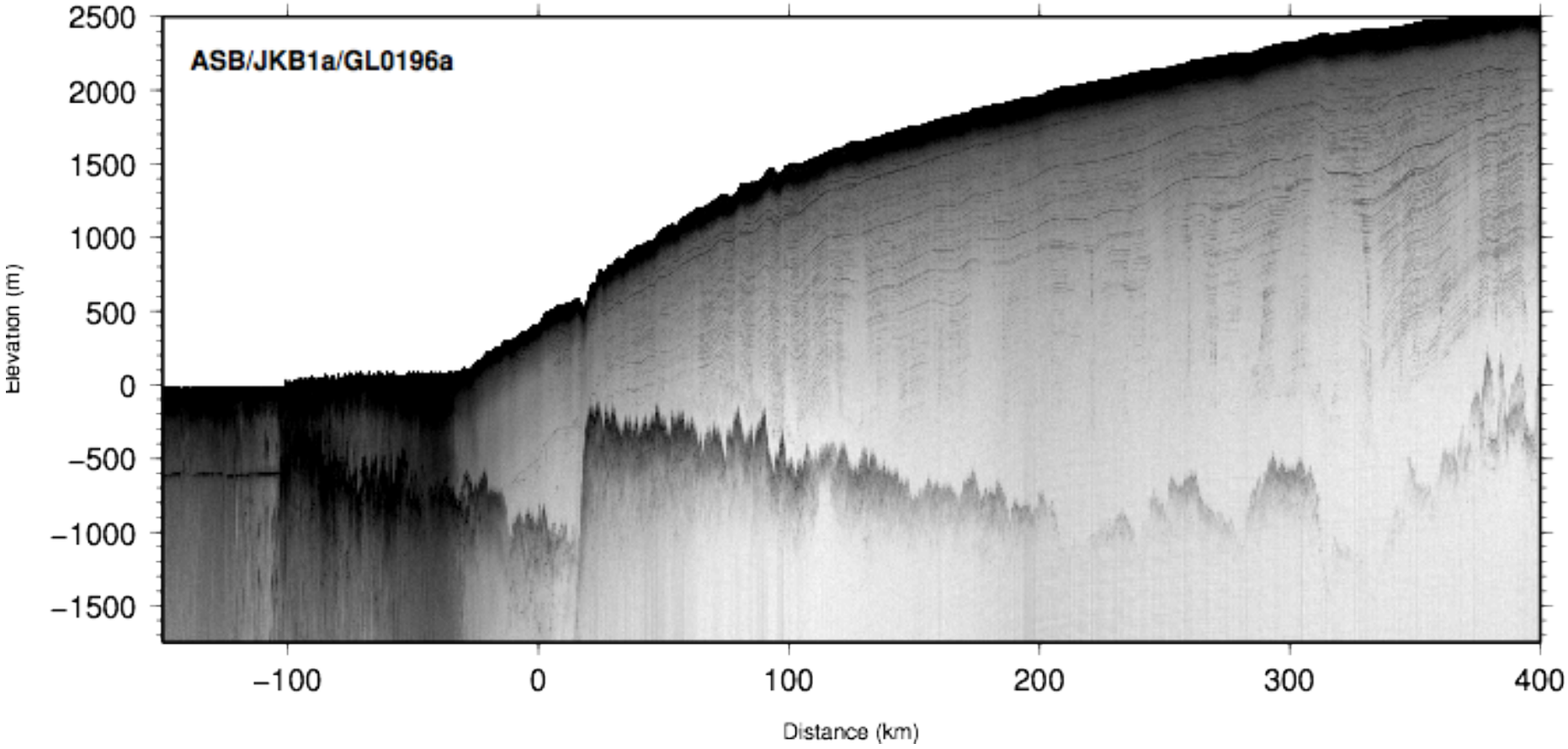
Totten Glacier



ICECAP Nadir Altimetry Swath Altimetry **Radar** Gravity Magnetics

Totten Glacier



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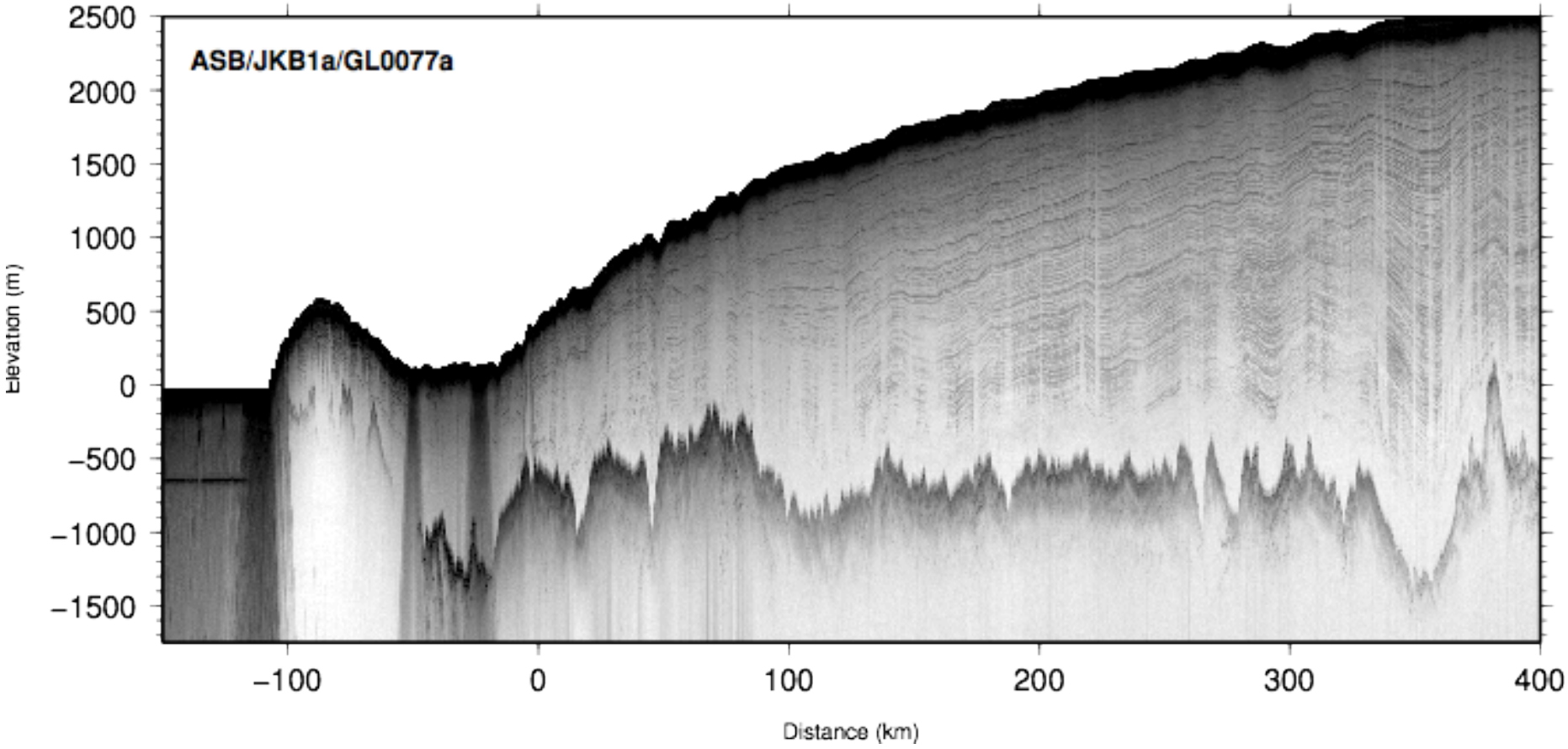

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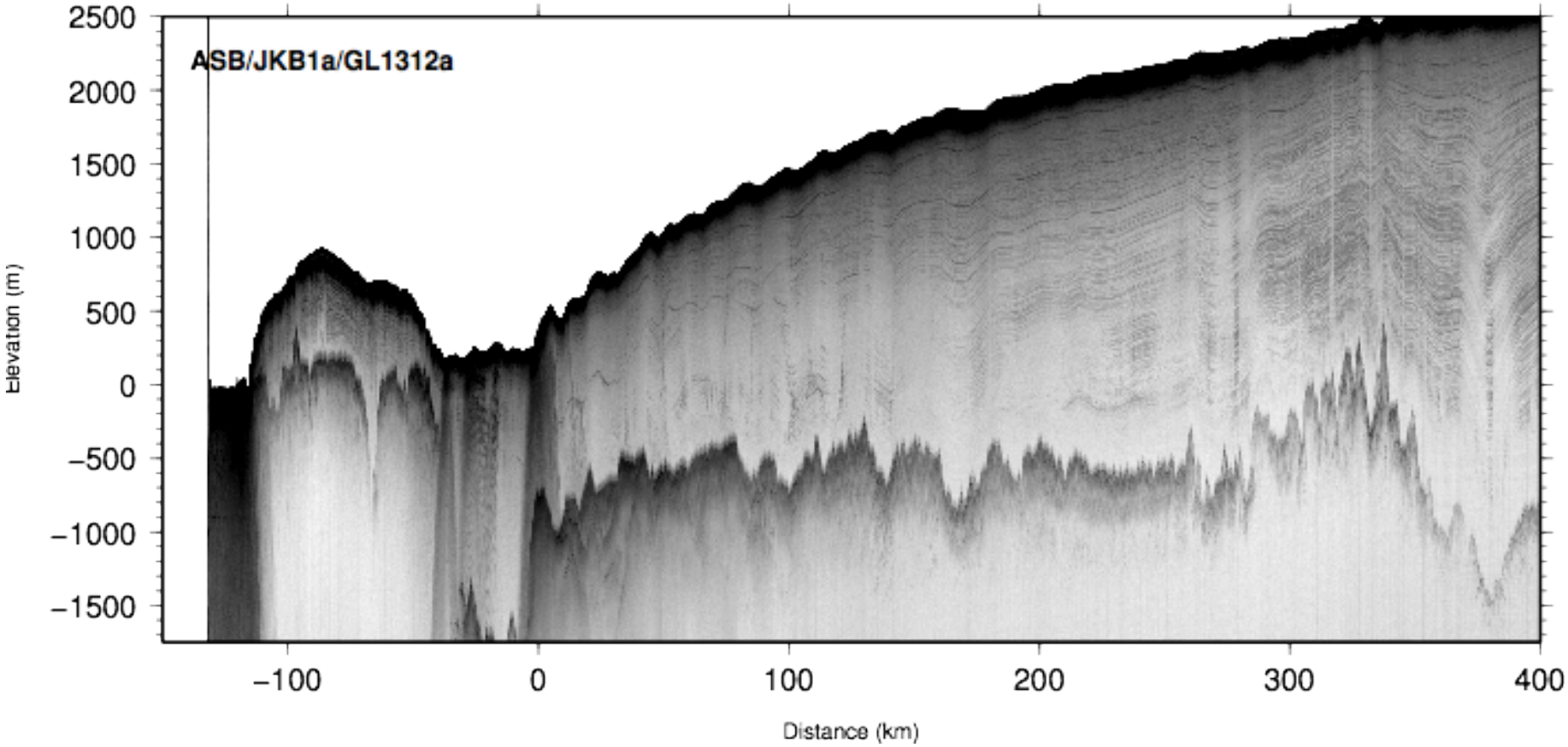
Totten Glacier



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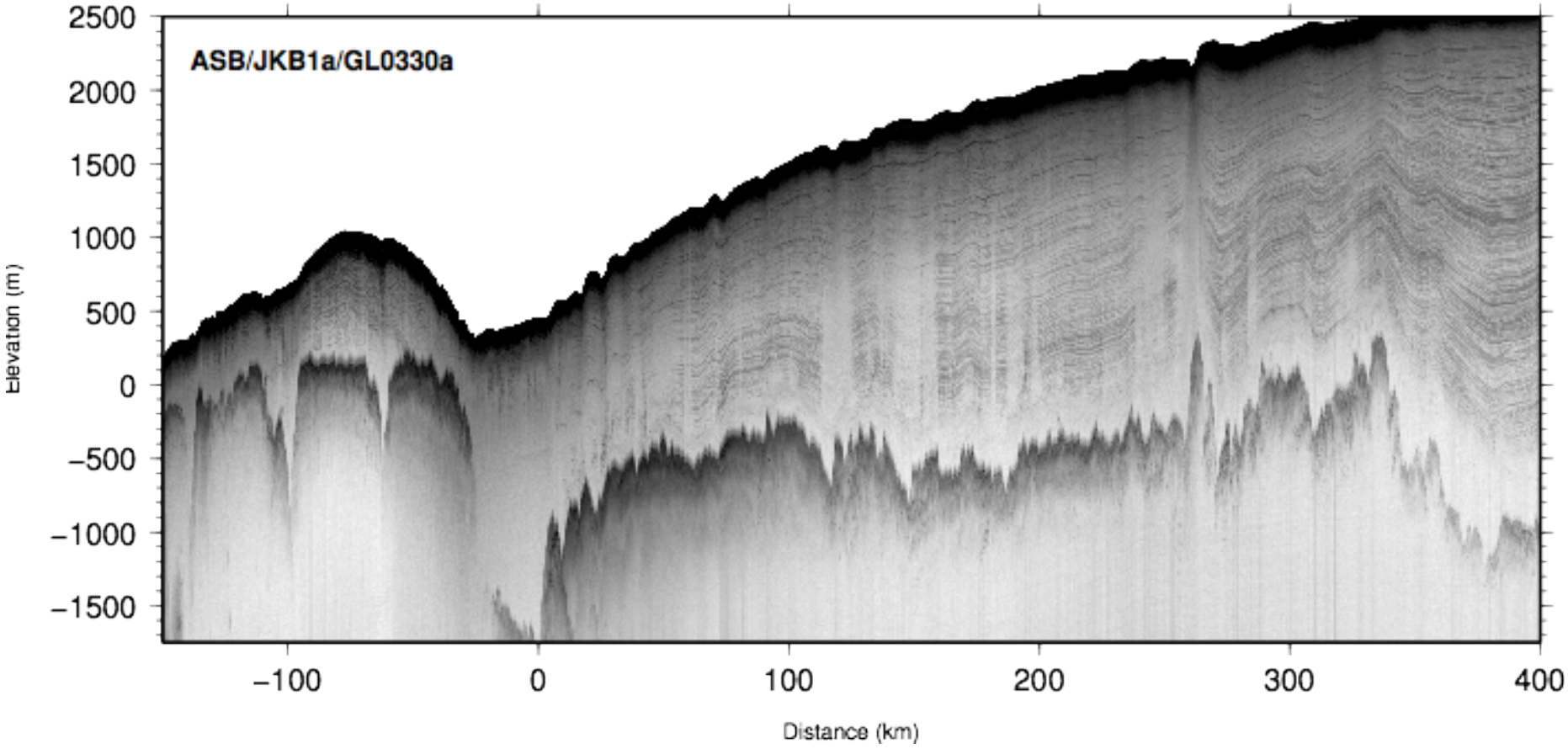
Totten Glacier



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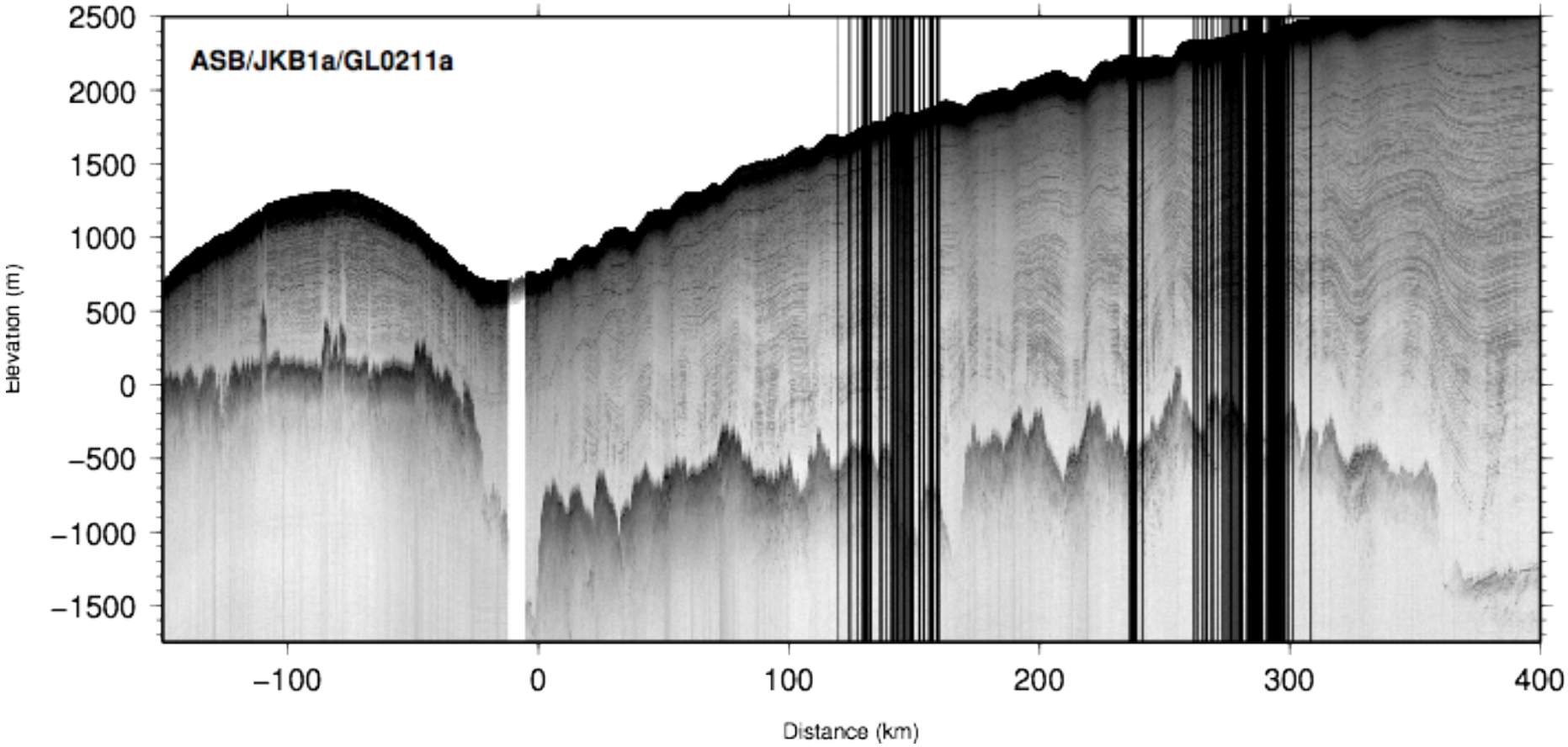
Totten Glacier



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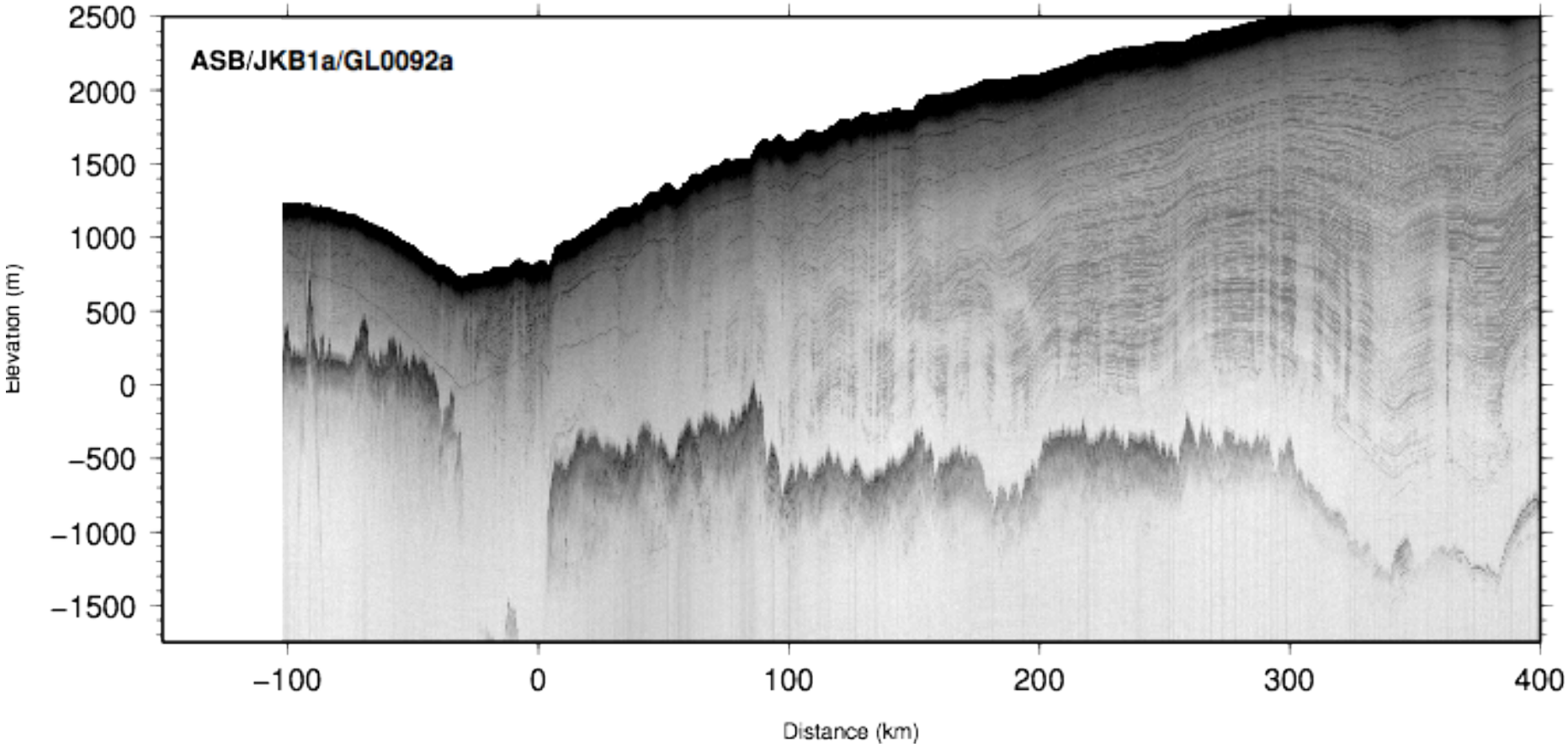

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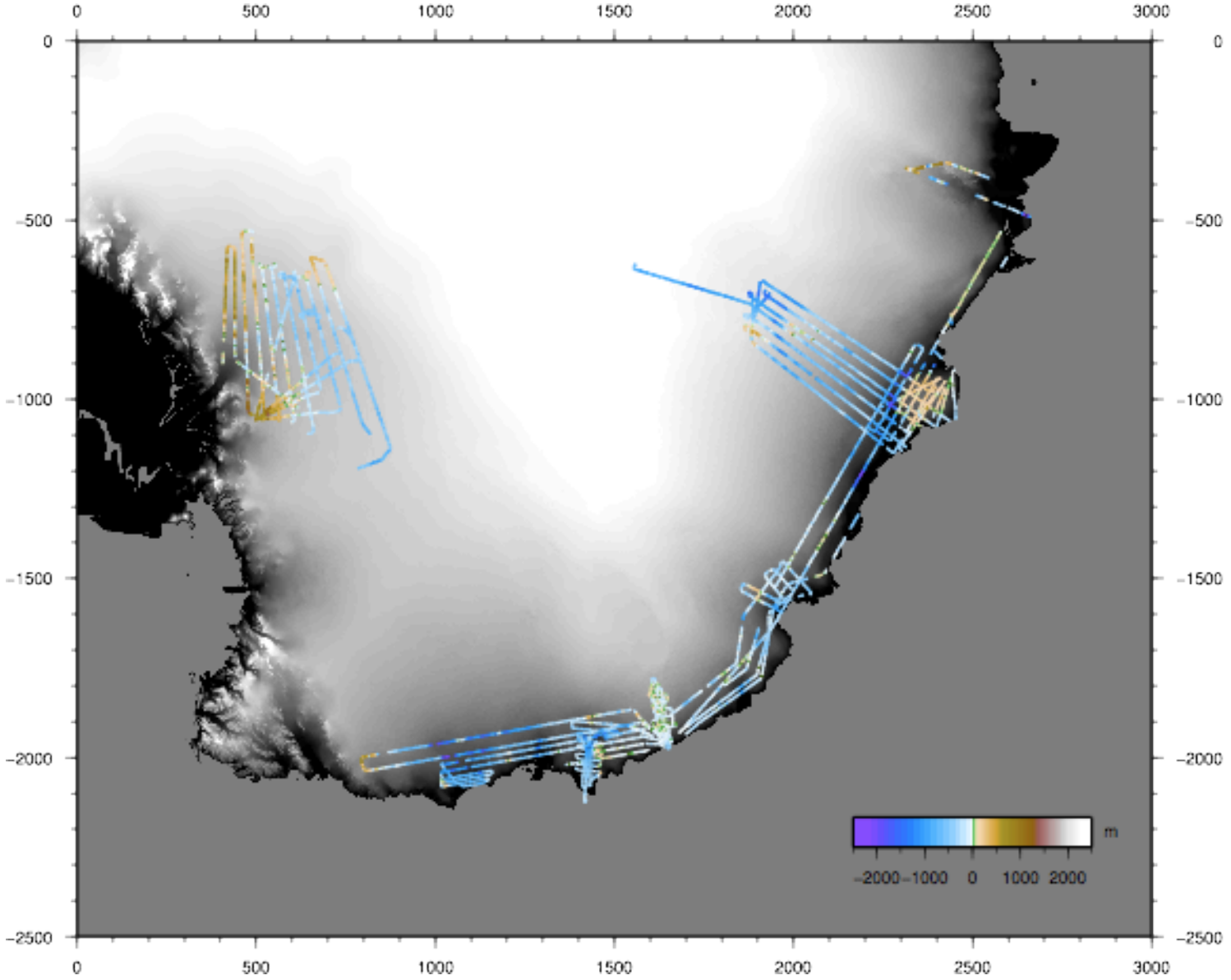

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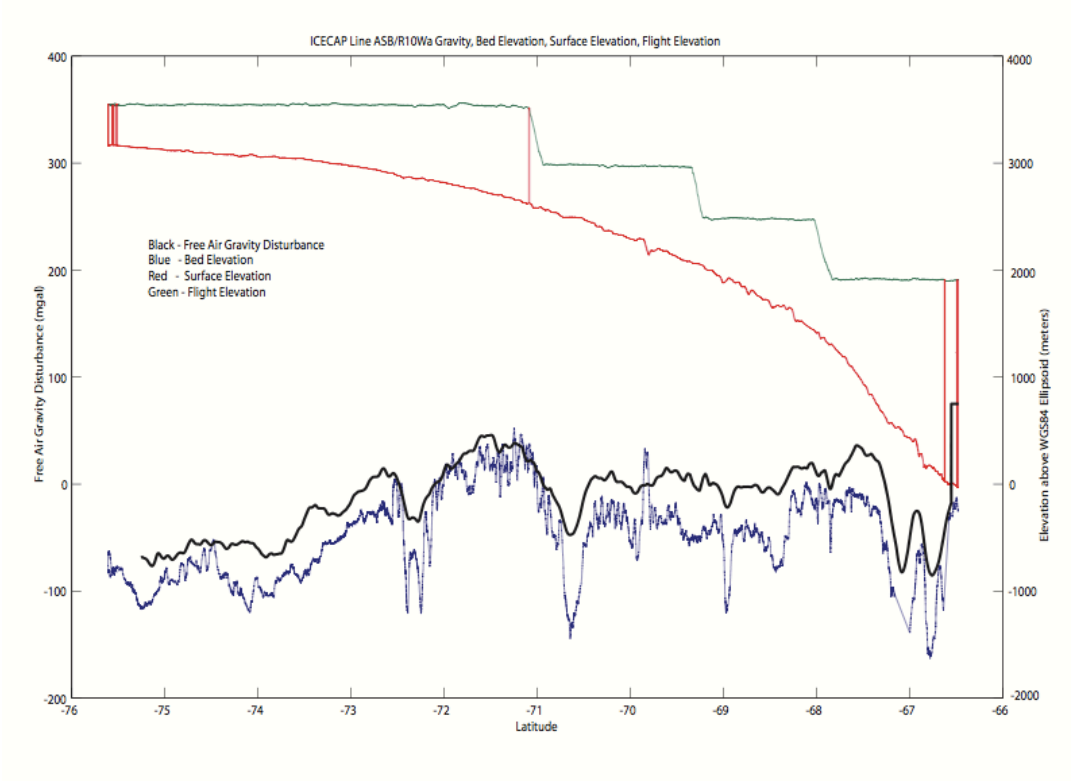
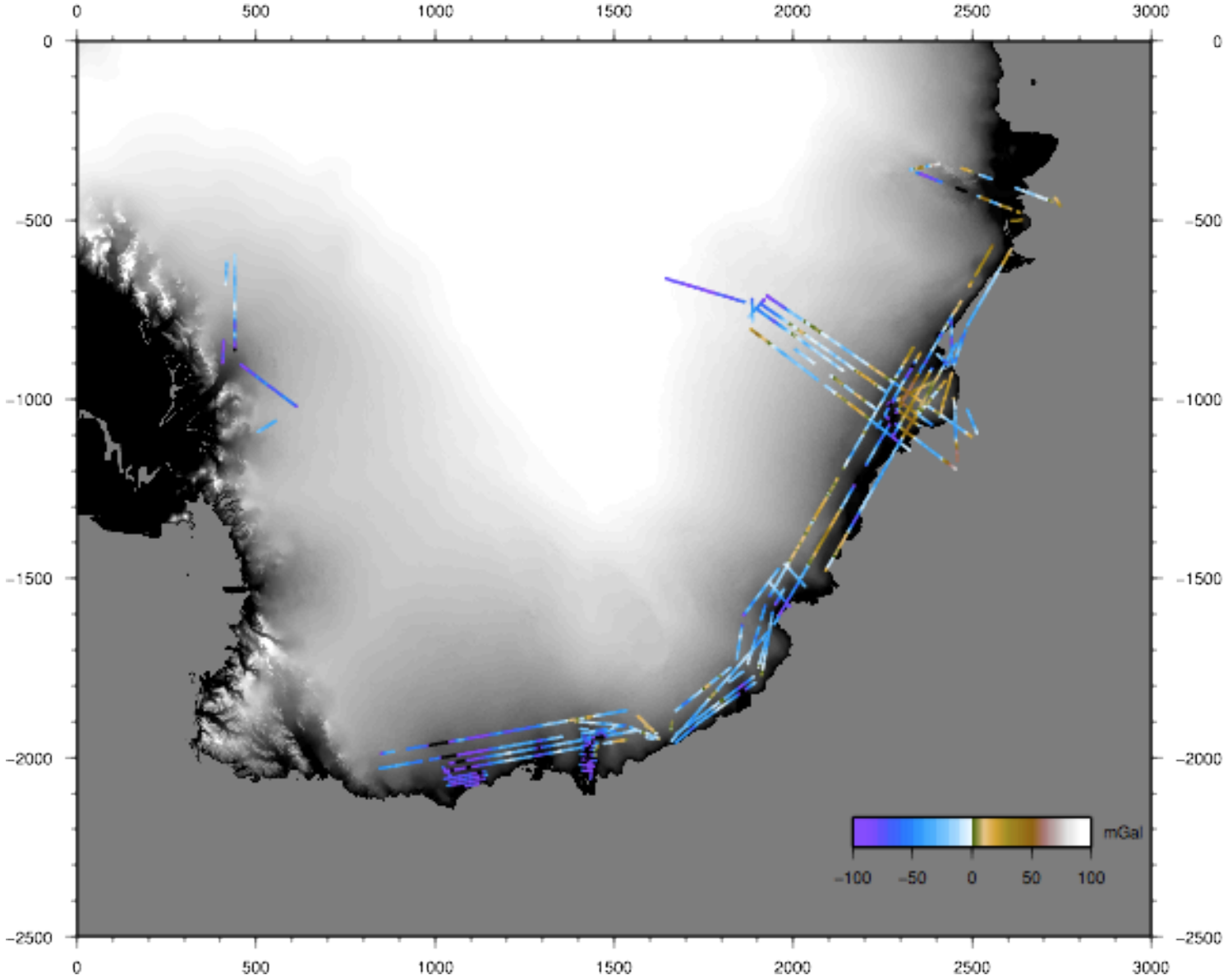
GRAVIMETER: BGM-3 airborne gravity meter (1 Hz ~ 25 meter) on loan from National Geospatial Intelligence Agency
(16495 km; 52% of ICECAP/OIB profiles) - dropouts due to failure platform for WSB, and transverse accelerations; elevation changes not very

POSITIONING: TOPCON GB-1000; Ashtech Z-Surveyor

DATA: Level 0 and filtered Level 2 data at NSIDC, data is not continued; 5 mGal RMS crossovers



ICECAP Nadir Altimetry Swath Altimetry Radar **Gravity** Magnetics



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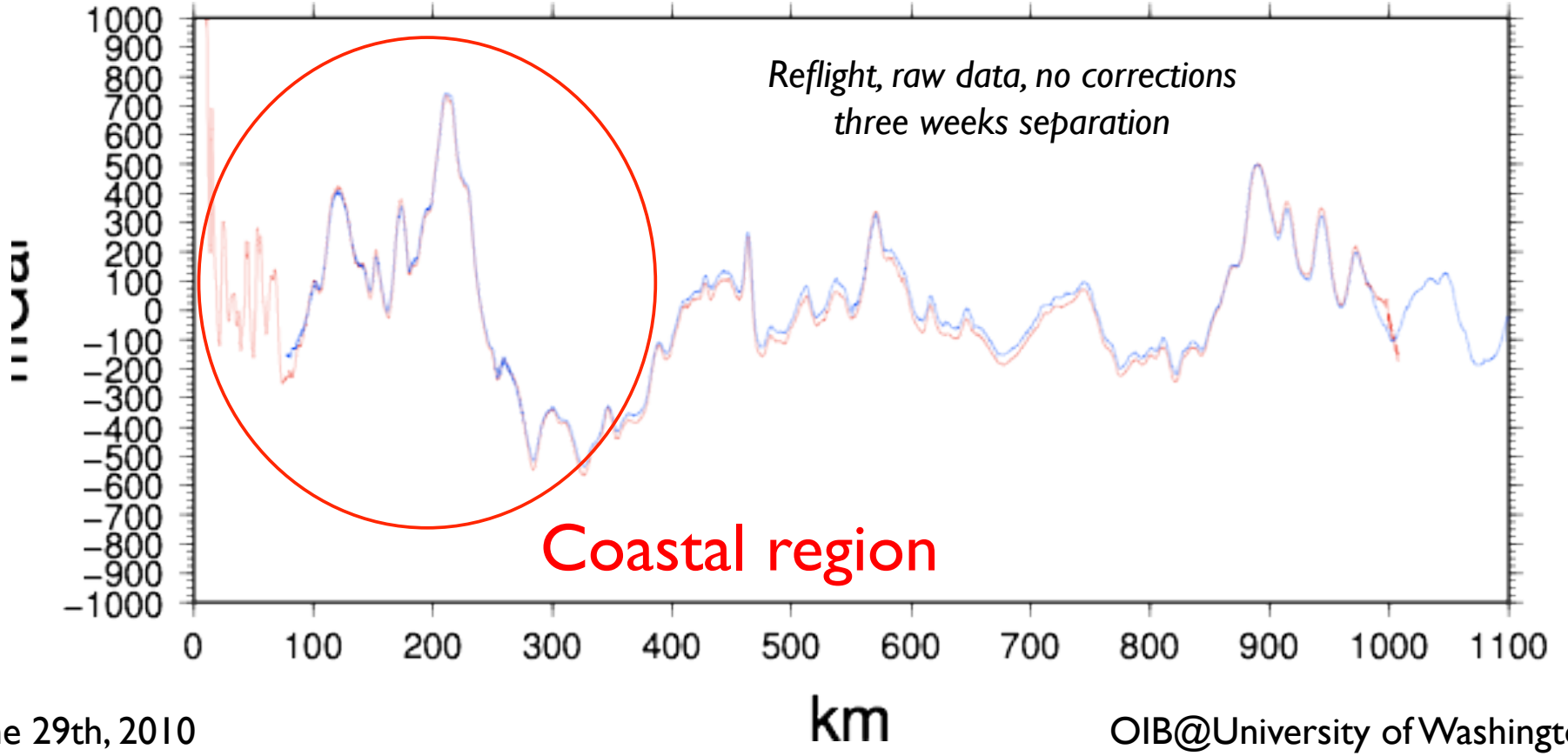
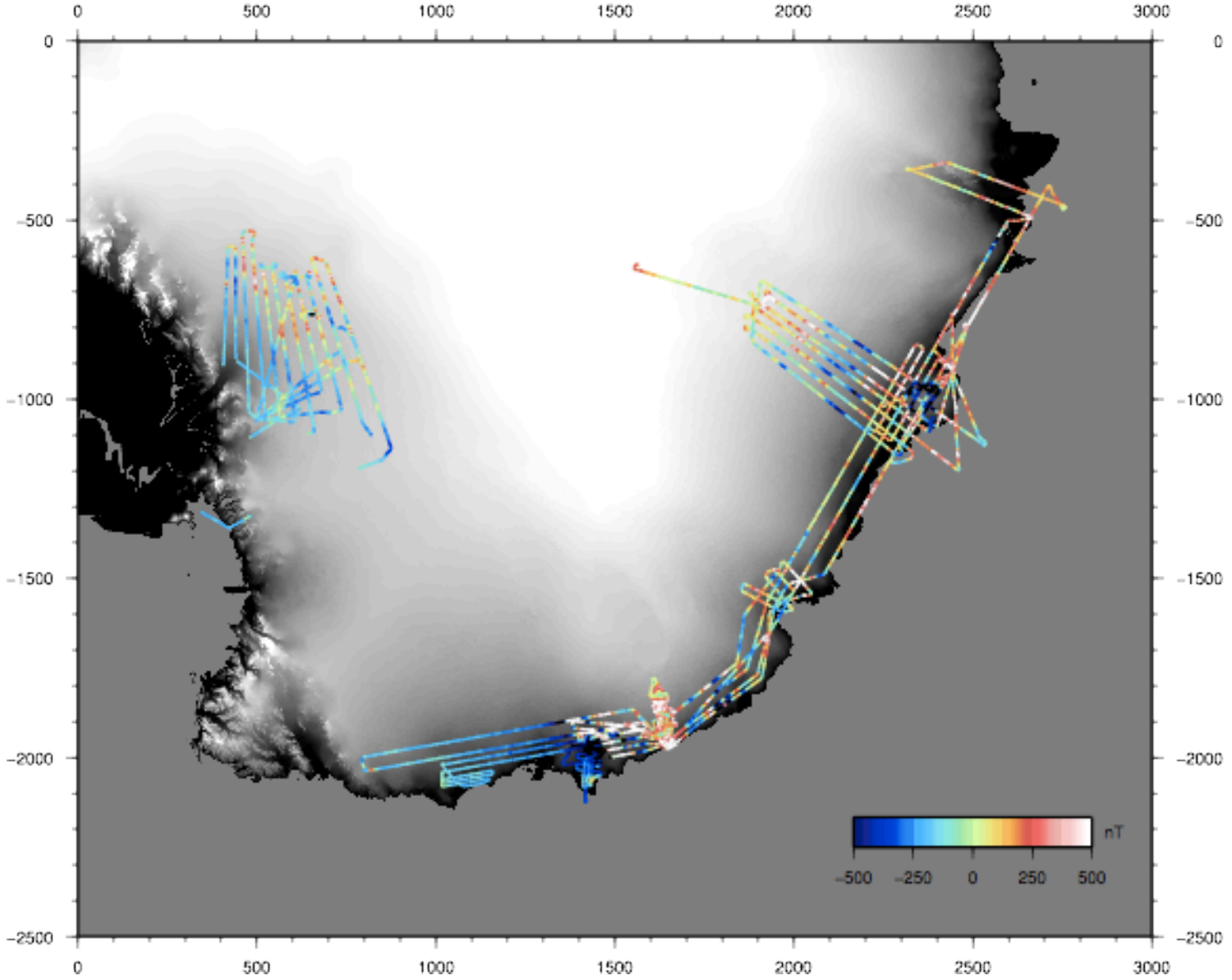
MAGNOTOMETER: G-823A tail mounted magnotometer, station data at Scot Base, DDU and Casey used for diurnal corrections.
(31664 km; 100% of ICECAP/OIB profiles) - some NWZ, MZG and ALG2 data affected by missing base station data, Casey flights occurred during bad mag window due to fog

DATA: Level 0 and filtered Level 2 data at NSIDC, data is not continued; IGRF09 used. ~80 mGal RMS crossovers



ICECAP Nadir Altimetry Swath Altimetry Radar Gravity Magnetics



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	Surface	Bed	Gravity	Magnetics
WSB	6546	7135	665	7759
ASB	7854	10011	9617	13647
NWZ	4570	5411	4500	5984
MZG	1322	2070	1713	2481
ALG2	1138	1628	0	1773
TOTAL	21430	26255	16495	31644

Summary

ICECAP has proven to be an adaptable international collaboration

Over 26,000 line kilometers of high resolution radar data have been collected (in addition to over 60,000 line kilometers of concurrent ICECAP/IPY data)

Extensive new potential fields measurements along the coast of East Antarctica

Laser altimetry shows potential, but more work is required to refine the product

Most raw data, and preliminary Level 2 data has been delivered to NSIDC in under four months since the end of the season.